

ATTACHED ARE:

- 1) A transcribed copy of BAA 98-02 as it appeared in the *Commerce Business Daily* (CBD) of October 15, 1997,
- 2) the BAA 98-02 Proposer Information Pamphlet 1 Network Engineering,
- 3) the BAA 98-02 Proposer Information Pamphlet 2 Quorum Capability Integration and Transition, and
- 4) the BAA 98-02 Proposer Information Pamphlet 3 SuperNet

Due to the possibility of transcription errors, the official *Commerce Business Daily* announcement takes precedence over this transcription in any disagreement between the two. The transcription is provided for your convenience only.

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**NEXT GENERATION INTERNET (NGI) SOL BAA 98-02 DUE 12/18/97 POC Dr. Bertram H. Hui, Dr. Gary M. Koob, and Ms. Hilarie Orman, DARPA/ITO, FAX: (703) 522-7161.**

The Next Generation Internet (NGI) initiative will develop novel network capabilities to enable a new wave of revolutionary applications. DARPA's role in NGI will involve: experimental research for advanced network technologies; and the development of ultra-high speed switching and transmission technologies that lay the groundwork for terabit per second (Tb/s) networks. The former activity will be organized into two components referred to as Network Engineering and Quorum. The latter is referred to as SuperNet. This announcement solicits proposals for these three components.

The objective of the Network Engineering component is to create a networking architecture and tools that greatly automate planning and reduce support functions, thus enabling the growth of networks by a factor of 100 or more while lowering the cost of network management.

The Quorum component of NGI is defining a revolutionary approach to network-based computing that positions adaptive quality-of-service (QoS) management as its central architectural principal. Quorum emphasizes the end system software aspects of this problem. As such, it is primarily concerned with leveraging enabling network services by coupling them to the application from the network interface through operating systems, middleware, and resource management layers.

The objective of the SuperNet component is to develop ultra-high speed multiplexing and transmission technologies together with advanced configuration management and control capabilities, and demonstrate end-to-end network connectivity involving tens of sites (nodes) and applications.

Development of these three component technologies will provide the pathway to terabit per second networks, supported by the appropriate network management and control function with assured end-to-end service.

Solicitation information pertaining to the three DARPA components can be obtained individually from the three Proposer Information Pamphlets (PIP). Other agencies participating in the NGI initiative may independently solicit abstracts and/or proposals in accordance with their own role in NGI.

### **PROGRAM SCOPE:**

Proposed research should investigate innovative approaches and techniques that lead to or enable revolutionary advances in the state-of-the-art. Research should result in prototype hardware and software demonstrating integrated concepts and approaches on Defense-relevant applications. Specifically excluded is research that primarily results in evolutionary improvement to the existing state of practice or focuses on a specific system or hardware solution. Integrated solution sets embodying significant technological advances are strongly encouraged over narrowly defined research endeavors. Partnering arrangements among academic, industrial, and non-profit research organizations are strongly encouraged.

### **GENERAL INFORMATION:**

A pre-proposal briefing will be held on Friday, October 31, 1997. Contact one of the administrative addresses below for details regarding time, location, and registration information.

In order to minimize unnecessary effort in proposal preparation and review, proposers are strongly encouraged to submit brief proposal abstracts in advance of full proposals. An original and eight (8) copies of the proposal abstract must be submitted to DARPA/ITO, ATTN: BAA 98-02, 3701 North Fairfax Drive, Arlington, VA 22203-1714, in time to reach DARPA by 4:00 PM (ET), Monday, November 10, 1997, to guarantee review. Upon review, DARPA will provide written feedback to offerors either encouraging or discouraging submission of full proposals.

Proposers must submit an original and eight (8) copies of full proposals in time to reach DARPA by 4:00 PM (ET), Thursday, December 18, 1997, in order to be considered. Proposers must obtain the appropriate pamphlet(s), BAA 98-02 Proposer Information, which provide further information on the areas of interest, submission, evaluation, funding processes, proposal abstracts, and full proposal formats. The pamphlets may be obtained by fax, electronic mail, or mail request to the administrative contact address given below, as well as at URL address <http://www.ito.darpa.mil/Solicitations.html>. Proposals not meeting the format described in the pamphlets may not be reviewed. This *Commerce Business Daily* notice, in conjunction with the pamphlets BAA 98-02 Proposer Information - Network Engineering; BAA 98-02 Proposer Information - Quorum; and BAA 98-02 Proposer Information - SuperNet, constitutes the total BAA.

No additional information is available, nor will a formal RFP or other solicitation regarding this announcement be issued. Requests for same will be disregarded.

The Government reserves the right to select for award all, some, or none of the proposals received.

All responsible sources capable of satisfying the Government's needs may submit a proposal that shall be considered by DARPA. Historically Black Colleges and Universities (HBCU) and Minority Institutions (MI) are encouraged to submit proposals and join others in submitting proposals. However, no portion of this BAA will be set aside for HBCU and MI participation due to the impracticality of reserving discrete or severable areas of this research for exclusive competition among these entities.

Evaluation of proposals will be accomplished through a scientific review of each proposal using the following criteria, which are listed in descending order of relative importance:

- (1) overall scientific and technical merit,
- (2) potential contribution and relevance to DARPA mission,
- (3) offeror's capabilities and related experience,
- (4) plans and capability to accomplish technology transition, and
- (5) cost realism.

All administrative correspondence and questions on this solicitation, including requests for information on how to submit a proposal abstract or proposal to this BAA, must be directed to one of the administrative addresses below for receipt by 4:00 PM, Thursday, December 11, 1997; e-mail or fax is preferred. DARPA intends to use electronic mail and fax for some of the correspondence regarding BAA 98-02. Proposals and proposal abstracts may not be submitted by fax; any so sent will be disregarded.

**The administrative addresses for this BAA are:**

Fax: 703-522-7161 Addressed to: DARPA/ITO, BAA 98-02  
Electronic Mail: baa98-02@darpa.mil  
Electronic File Retrieval: <http://www.ito.darpa.mil/Solicitations.html>  
Mail: DARPA/ITO  
ATTN: BAA 98-02  
3701 North Fairfax Drive  
Arlington, VA 22203-1714

SPONSOR: Defense Advanced Research Projects Agency (DARPA), Contracts  
Management Office (CMO), 3701 N. Fairfax Dr., Arlington, VA  
22203-1714

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## **BAA 98-02 PROPOSER INFORMATION PAMPHLET 1 NETWORK ENGINEERING**

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The Defense Advanced Research Projects Agency (DARPA) often selects its research efforts through the Broad Agency Announcement (BAA) process. The BAA will appear first in the *Commerce Business Daily*, published by the U.S. Government, Department of Commerce. The following information is for those wishing to respond to the Broad Agency Announcement.

### **NEXT GENERATION INTERNET: NETWORK ENGINEERING SOL BAA 98-02 DUE 12/18/97 POC Ms. Hilarie Orman, DARPA/ITO, FAX: (703) 522-7161.**

The NGI initiative will create a networking architecture and tools that greatly reduce and automate planning and support functions, thus enabling the growth of networks by a factor of 100 or more while lowering the cost of management. This announcement solicits research for the development of technologies to predict, analyze, and control network performance. Architecturally, the solutions will be pervasively embedded in the network elements and protocols. In order to achieve a high degree of flexibility and utility for the lifetime of the networking technology, the tools should be based on general and extensible paradigms, such as hybrid systems, real-time and high-fidelity simulation, self-organizing algorithms, and semantic-based pattern matching. Technologies proposed in response to this announcement should be dramatic advances in the state-of-the-art, not incremental capabilities built on current network management tools.

Achieving a highly reliable, efficient, and service-rich network will require research that brings to bear concentrated analysis facilities on the problems of automated control and diagnosis. Possible research areas include: real-time (and faster than real-time) correlation of simulations, measurements, and models; innovative control algorithms based on multiple, sophisticated models of network system behavior; combinations of active and passive data collection methods for anomaly identification and control; discovery of anomalies and useful control mechanisms through real-time correlation techniques; codification of expert knowledge; and novel methods of model combination and correlation.

Proposals should address the engineering aspects of operating over multiple technologies and interconnections; the proposed techniques must be useful under future scenarios including widespread optical networks using WDM, satellite links, and mobile wireless networks. Approaches may focus on particular technologies but must demonstrate widespread applicability.

Innovations in monitoring, data collection and storage, on-line simulation and distributed, cooperative simulation, and other scalable techniques for handling large volumes of data and on-line processing may be addressed as parts of the research proposals but should not be the principal focus. Both software and hardware solutions are encouraged.

Proposals should indicate the major thrust of the research goals in one to three of the following technical topic areas:

**1. AUTOMATED ANALYSIS, DIAGNOSIS, AND CONTROL:** The correlation of observed and expected behavior in real-time for validation or predictive purposes will require efficient and powerful tools, based on models, heuristics, simulations, and empirical data. The analysis must be tied to control of the network configuration for elements and protocols. The ability to utilize real-time models and simulations may be used for sophisticated control algorithms, and for diagnosis. The translation of the diagnostic recommendations into commands that change the configuration of network elements, through software and/or firmware commands and protocols, should be addressed. Command compilers, self-organizing command generators, or configuration generators are among possible approaches to fast planning and real-time command generation.

Proposals should address the intellectual basis as well as the experimental means by which the technology will be demonstrated both in operational environments and also a simulation environment that is either widely used or under development in an existing DARPA sponsored program.

**2. HIGH-FIDELITY, INTEGRATED MONITORING AND HARDWARE:**

Distributed techniques for collecting information about all levels of network performance and service quality constitute the basis for the network engineering methods in this program. Proposals should address methods for collecting, storing, and distributing monitoring data to the sites that will analyze it and issue control commands to network elements.

**3. MODELING AND SIMULATION FOR REAL-TIME ANALYSIS, DIAGNOSIS AND CONTROL:**

**a) Executable, high-fidelity models.** This topic seeks innovative models for large-scale network behavior. The ability to span several levels of granularity of behavior is important, as is the ability to parameterize the model with empirical data. The models should be capable of validating or predicting network behavior in real-time. Models should also allow manipulation of parameters for subjective analysis that can be used for prediction, planning, and validation. **b) Simulation.** Methods for simulating ultrafast, large-scale networks are sought, as well as highly scalable methods for simulating protocols and hardware in real-time. Simulations that run within the network nodes themselves may be addressed, as well as those that require dedicated computing resources.

**4. PROTOCOL-ORIENTED VISUALIZATION OF DISTRIBUTED**

**PROCESSING:** Visualization techniques that can illuminate network activity patterns

on a large-scale for planning and operational purposes are to be used as the foundation for making wide-scale distributed processing highly efficient. All of the network communication streams that support a distributed application must be viewed as a coherent pattern. The application's effect on the overall network (and the network's effect on it), will be displayed for analysts and planners to use in designing and changing large-scale networks. Visualization of simulation and monitoring data described in the other technical topic areas should be tied efficiently to the overall display.

**5. FINE-GRAINED MANAGEMENT AND PROVISIONING:** Novel techniques for managing internet technology over optical internetworks are sought. Correlation of color/wavelength assignments with routing information and/or high-volume communication stream management are examples of possible topics. Of particular interest is the ability to easily provision widely varying service levels over ultrafast networks; service levels may range from, for example, best effort one megabit/second lines up to guaranteed latency 100 gigabit channels. Software and hardware solutions to the aggregation of traffic with widely divergent characteristics are sought.

**6. SECURITY FOR ULTRAFAST NETWORKS:** Traditional methods of security assurance will not scale readily to networks of greater size and speeds, but DoD requirements in this area remain critical. Novel approaches to ultrafast authentication, integrity, and privacy methods are sought, as well as secure management techniques for all-optical networks. Intrusion detection and other non-cryptographic protection methods for very large and ultrafast networks may also be addressed.

**7. ARCHITECTURAL FRAMEWORKS:** Proposals that delineate an overall architectural solution, into which tools satisfying the areas above can be integrated, are also encouraged, especially those with a practical framework that is inherently suited to very large networks that are self-configuring and automatically maintained. The formation of autonomous analysis clusters that actively control the configuration of networking elements in a region is an example of an architectural solution that might be utilized, as are uniformly applied, self-organizing element architectures. Proposals that combine an architectural framework with any other technical topic areas should be structured into separable options. To the extent possible, the options relating to the other topic areas should be independent of the specific architectural framework that is proposed.

#### **SUBMISSION PROCESS:**

Proposers are strongly encouraged to submit a proposal abstract in advance of actual proposals. This procedure is intended to minimize unnecessary effort in proposal preparation and review. An original and eight (8) copies of the proposal abstract must be submitted to DARPA/ITO, ATTN: BAA 98-02, 3701 North Fairfax Drive, Arlington, VA 22203-1714, in time to reach DARPA by 4:00 PM (ET), Monday, November 10, 1997, to guarantee review. An original and eight (8) copies of each proposal must be submitted to the administrative address for this BAA in time to reach DARPA by 4:00 PM (ET) Thursday, December 18, 1997, in order to be considered. DARPA will

acknowledge receipt of submissions and assign control numbers that should be used in all further correspondence regarding abstracts and proposals.

DARPA will attempt to review proposal abstracts within 21 days after receipt and will make a recommendation encouraging or discouraging formal proposal submissions. Proposal abstracts will be reviewed as they are received. Early submissions are strongly encouraged. Regardless of the recommendation, the decision to propose is the responsibility of the proposer. All submitted proposals will be fully reviewed regardless of the disposition of the proposal abstract.

Restrictive notices notwithstanding, proposals may be handled, for administrative purposes only, by a support contractor. This support contractor is prohibited from competition in DARPA technical research and is bound by appropriate non-disclosure requirements. All proposals will be reviewed by Government officials only.

## **EVALUATION AND FUNDING PROCESSES:**

Proposals will not be evaluated against each other since they are not submitted in accordance with a common work statement. DARPA's intent is to review proposals as soon as possible after they arrive; however, proposals may be reviewed periodically for administrative reasons. For evaluation purposes, a proposal is the document described in PROPOSAL FORMAT (see below). Other supporting or background materials submitted with the proposal will be considered for the reviewer's convenience only and not considered as part of the proposal.

Evaluation of proposals will be accomplished through a scientific review of each proposal using the following criteria, which are listed in descending order of relative importance:

- (1) overall scientific and technical merit,
- (2) potential contribution and relevance to DARPA mission,
- (3) offeror's capabilities and related experience,
- (4) plans and capability to accomplish technology transition, and
- (5) cost realism.

As soon as the proposal evaluation is completed, the proposer will be notified of selectability or non-selectability. Selectable proposals will be considered for funding; non-selectable proposals will be destroyed. (One copy of non-selectable proposals may be retained for filing purposes.) Not all proposals deemed selectable will be funded. Decisions to fund selectable proposals will be based on funds available, scientific and technical merit, and potential contribution and relevance to DARPA's mission. DARPA may retain some selectable proposals for a period of up to one year in order to reconsider those proposals for funding. Submitters of those retained proposals will receive notification to that effect.

The Government reserves the right to select for award all, some, or none of the proposals received. Proposals identified for funding may result in a contract, grant, cooperative

agreement, or other transaction depending upon the nature of the work proposed, the required degree of interaction between parties, and other factors. If warranted, portions of resulting awards may be segregated into pre-priced options.

## **GENERAL INFORMATION:**

A pre-proposal briefing will be held on Friday, October 31, 1997. Contact one of the administrative addresses below for details regarding time, location, and registration information. The intent of this briefing is to provide information regarding the BAA and to answer clarifying questions. Clarifying questions can be submitted in advance to the administrative address provided below. Remarks and explanations provided at this meeting shall not qualify the terms of the BAA. The terms and specifications of the BAA remain unchanged unless the BAA is amended in writing by DARPA.

A copy of the briefing presentation slides, summarized questions and answers resulting from the meeting, and a briefing attendee list will be available after the briefing at URL <http://www.ito.darpa.mil/Solicitations.html> or by contacting the administrative contact.

Proposals not meeting the format described in this pamphlet may not be reviewed. Proposals and proposal abstracts may not be submitted by fax; any so sent will be disregarded. The *Commerce Business Daily* notice, in conjunction with the pamphlets BAA 98-02 Proposer Information - Network Engineering; BAA 98-02 Proposer Information - Quorum; and BAA 98-02 Proposer Information - SuperNet, constitutes the total BAA. No additional information is available, nor will a formal RFP or other solicitation regarding this announcement be issued. Requests for same will be disregarded. All responsible sources capable of satisfying the Government's needs may submit a proposal that shall be considered by DARPA. Historically Black Colleges and Universities (HBCU) and Minority Institutions (MI) are encouraged to submit proposals and join others in submitting proposals. However, no portion of this BAA will be set aside for HBCU and MI participation due to the impracticality of reserving discrete or severable areas of this research for exclusive competition among these entities.

## **PROPOSAL ABSTRACT FORMAT:**

Proposal abstracts are encouraged in advance of full proposals in order to provide potential offerors with a rapid response and to minimize unnecessary effort. The abstract submission should be clearly marked "PROPOSAL ABSTRACT" and should include a cover sheet and a technical section.

The cover sheet should include: (1) BAA number; (2) Technical topic area; (3) Proposal title; (4) Technical point of contact including: name, telephone number, electronic mail address, fax (if available) and mailing address; (5) Administrative point of contact including: name, telephone number, electronic mail address, fax (if available) and mailing address; (6) List of key personnel; (7) Summary of the costs of the proposed research, including total base cost, estimates of base cost in each year of the effort, estimates of itemized options in each year of the effort, and cost sharing if relevant; and



(8) Contractor's type of business, selected from among the following categories: "LARGE BUSINESS," "SMALL DISADVANTAGED BUSINESS," "OTHER SMALL BUSINESS," "HBCU," "MI," "OTHER EDUCATIONAL," or "OTHER NONPROFIT." The cover sheet is limited to one page.

The technical section of the abstract should include the following: A. {1 page} Innovative claims for the proposed research. This page is the centerpiece of the abstract and should succinctly describe the unique proposed contribution; and B. {4 pages} Technical rationale, technical approach and constructive plan for accomplishment of technical goals in support of innovative claims and deliverable products. Include comparison with other ongoing research indicating advantages and disadvantages of the proposed effort.

The total length of the abstract should not exceed six pages including the cover sheet. Abstracts only (not full proposals) may be submitted via electronic mail to baa98-02@darpa.mil. E-mail submissions must be formatted as plain ASCII, 72 characters to the line, 60 lines to the page. This is the only electronic format that will be accepted. No formal transmittal letter is required.

## **PROPOSAL FORMAT:**

Proposals shall include the following sections, each starting on a new page (where a "page" is 8-1/2 by 11 inches with type not smaller than 12 point) and with text on one side only. The submission of other supporting materials along with the proposal is strongly discouraged. Sections I and II of the proposal shall not exceed 41 pages. Maximum page lengths for each section are shown in braces { } below.

### **Section I. Administrative**

{1} Cover Page including: (1) BAA number; (2) Technical topic area; (3) Proposal title; (4) Technical point of contact including: name, telephone number, electronic mail address, fax (if available) and mailing address; (5) Administrative point of contact including: name, telephone number, electronic mail address, fax (if available) and mailing address; (6) Summary of the costs of the proposed research, including total base cost, estimates of base cost in each year of the effort, estimates of itemized options in each year of the effort, and cost sharing if relevant; and (7) Contractor's type of business, selected from among the following categories: "LARGE BUSINESS," "SMALL DISADVANTAGED BUSINESS," "OTHER SMALL BUSINESS," "HBCU," "MI," "OTHER EDUCATIONAL," or "OTHER NONPROFIT."

### **Section II. Detailed Proposal Information**

This section provides the detailed discussion of the proposed work necessary to enable an in-depth review of the specific technical and managerial issues. Specific attention must be given to addressing both risk and payoff of the proposed work that make it desirable to DARPA.

- A. {1} Innovative claims for the proposed research. This page is the centerpiece of the proposal and should succinctly describe the unique proposed contribution.
- B. {18} Technical rationale, technical approach and constructive plan for accomplishment of technical goals in support of innovative claims and deliverable products.
- C. {2} Deliverables associated with the proposed research. Include in this section all proprietary claims to results, prototypes, or systems supporting and/or necessary for the use of the research, results, and/or prototype. If there are no proprietary claims, this should be stated. The offeror must submit a separate list of all technical data or computer software that will be furnished to the Government with other than unlimited rights (see DFARS 227.)
- D. {3} Statement of Work (SOW) written in plain English, outlining the scope of the effort and citing specific tasks to be performed and specific contractor requirements.
- E. {1} Schedule of milestones for the proposed research.
- F. {2} Technology Transfer. Description of the transferable technology and expected technology transfer path.
- G. {3} Comparison with other ongoing research indicating advantages and disadvantages of the proposed effort.
- H. {4} List of key personnel, concise summary of their qualifications, and discussion of proposer's previous accomplishments and work in this or closely related research areas. Indicate the level of effort to be expended by each person during each contract year and other (current and proposed) major sources of support for them and/or commitments of their efforts.
- I. {1} Description of the facilities that would be used for the proposed effort.
- J. {5} Cost by task, with breakdown into accounting categories and equipment for the entire contract and for each contract year. Where the effort consists of multiple portions that could reasonably be partitioned for purposes of funding, these should be identified as contract options with separate cost estimates for each. Details of any cost sharing should also be included.

Awards made under this BAA may be subject to the provisions of the Federal Acquisition Regulation (FAR) Subpart 9.5, Organizational Conflict of Interest. All offerors and proposed subcontractors must affirmatively state whether they are supporting any DARPA technical office(s) through an active contract or subcontract. "Support contract" or "support contractor" includes a contract or subcontract for acquisition of System Engineering and Technical Assistance (SETA) services, and other

support service contracts in which any one of the following situations apply: have personnel who regularly maintain offices or frequently occupy space within DARPA; maintain external spaces in which DARPA personnel maintain offices or frequently occupy; or have personnel with any access to the DARPA fiscal database, EIS, or contractual or programmatic documentation related to other than their own contact(s). All affirmations must state which office(s) the offeror supports, and identify the prime contract number. Affirmations should be furnished at the time of proposal submission. All facts relevant to the existence or potential existence of organizational conflicts of interest, as that term is defined in FAR 9.501, must be disclosed in Section II., H of the proposal, organized by task and year. This disclosure shall include a description of the action the Contractor has taken, or proposes to take, to avoid, neutralize, or mitigate such conflict.

### **Section III. Additional Information**

A bibliography of relevant technical papers and research notes (published and unpublished) that document the technical ideas upon which the proposal is based. Copies of not more than three relevant papers may be included in the proposal submission; provide one set for the original proposal and one set for each of the eight proposal copies. Please note: the materials listed in Section III. Additional Information, and submitted with the proposal, will be considered for the reviewer's convenience only and not considered as part of the proposal for evaluation purposes.

#### **The administrative addresses for this BAA are:**

Fax: 703-522-7161 Addressed to: DARPA/ITO, BAA 98-02  
Electronic Mail: baa98-02@darpa.mil  
Electronic File Retrieval: <http://www.ito.darpa.mil/Solicitations.html>  
Mail: DARPA/ITO  
ATTN: BAA 98-02  
3701 North Fairfax Drive  
Arlington, VA 22203-1714

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## **BAA 98-02 PROPOSER INFORMATION PAMPHLET 2 QUORUM CAPABILITY INTEGRATION AND TRANSITION**

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The Defense Advanced Research Projects Agency (DARPA) often selects its research efforts through the Broad Agency Announcement (BAA) process. The BAA will appear first in the *Commerce Business Daily*, published by the U.S. Government, Department of Commerce. The following information is for those wishing to respond to the Broad Agency Announcement.

**NEXT GENERATION INTERNET: QUORUM CAPABILITY INTEGRATION  
AND TRANSITION SOL BAA 98-02 DUE 12/18/97 POC Dr. Gary M. Koob,  
DARPA/ITO, FAX: (703) 522-7161.**

The Defense Advanced Research Projects Agency (DARPA) solicits proposals for the integration, evaluation, demonstration, and transfer of technologies being developed under the Quorum global distributed computing program and selected technologies from related programs.

## **1. INTRODUCTION**

The Quorum component of NGI is defining a revolutionary approach to network-based computing that positions adaptive quality-of-service (QoS) management as its central architectural principle.

Affordability considerations and emerging Defense mission demands emphasizing integration and interoperability of capabilities across platforms, services, and coalitions are driving the DoD toward increased use of commercial off-the-shelf components and distributed architectures. Existing approaches, however, are incapable of (a) dynamically balancing the real-time demands of mission-critical applications with those of traditional workloads or (b) rapid adaptation to changing resource availability while maintaining QoS assurances.

The goal of the DARPA/ITO Quorum effort is to enable global distributed computing for military applications by addressing the issues identified above in a manner consistent with open systems principles. The central concept is a framework that permits reconciliation and assurance of QoS expectations with the available capabilities of a highly dynamic and unpredictable infrastructure. Quorum emphasizes the system software aspects of this problem. As such, it is primarily concerned with leveraging enabling network services by coupling them to the application from the network interface through operating systems, middleware, and resource management layers.

## **2. QUORUM INTEGRATION EFFORT**

A rapid prototype effort was launched in July 1997 to lead the definition of a baseline QoS architecture and demonstrate the interoperability of selected technologies.

An integration effort is now sought to: evaluate and integrate selected technologies (Section 3) into a series of reference implementations; distribute and support the reference implementations; coordinate the various research and technology projects; mediate technology transfer to DoD receptors and assist with demonstrations; and facilitate technology transfer to industry and standards bodies.

Given that research on the technical components will continue in parallel with the development of the reference implementations, a “just-in-time” integration strategy is required to ensure that the most current version of each technology is available. The Quorum integration team will work with the relevant technology providers to ensure that

the individual components comply with the overall system architecture and interoperate effectively while the technology providers retain the responsibility and flexibility to maintain and evolve their respective technologies.

It is highly desirable that Quorum demonstrate an open systems architecture in which higher layers may readily exploit advanced OS and network capabilities where available and compensate where absent. Quorum components should demonstrate the modularity and cost benefits of traditional layered architectures, relying on the translucence concept to achieve the end-to-end QoS properties currently available only in customized monolithic systems.

The Quorum integration team will consist of a lead integrator and may include one or more specialized integrators. Although proposals to assume multiple roles are not precluded, they should be structured with separate options for each role. All offerors should be prepared to work cooperatively with the other integration team participants and with other DARPA-sponsored researchers.

## **2.1 Lead Integrator Role - Technical Activities**

This section defines the base scope of the lead integration effort. Offerors are encouraged to propose additional scope in the form of options to allow the timely exploitation of technological and transition opportunities that may arise over the course of the program. The lead integrator is anticipated to play a pivotal role in the program through the following specific technical activities:

### **2.1.1 Integration and Evaluation**

#### **(a) Operating Systems Integration:**

The Quorum program is developing advanced operating system technologies supporting the traceable execution path, differentiated service class, and event-driven variant selection concepts as well as flexible security. Successful demonstration and transition of these technologies will require the coherent integration of these mechanisms into at least one widely deployed commercial operating system. Offerors must therefore propose one specific commercial OS to serve as this base, identifying either a WIN32-compatible platform or a Posix-compliant platform. (Multiple alternatives may be proposed as costed options.)

Furthermore, as a concurrent activity, the integration effort must maintain a technology base that keeps pace with research developments, facilitating “just-in-time” insertion of new capabilities while allowing providers to retain ownership of and maintenance responsibility for their technical concepts, preventing the establishment of divergent prototypes. Offerors must therefore present a plan for collaborating with technology providers to effect this integration, returning the enhanced OS to the provider as a base for further research, and inserting subsequent provider upgrades of the enhancements into testbeds and demonstrations.

The lead integrator (in cooperation with the specialized integrators) should further develop a translucent interface to the enhanced OS to facilitate effective delivery and control of the new capabilities to applications in the context of the QoS architecture.

**(b) Reference Implementations:**

Quorum capabilities will be demonstrated through a series of reference implementations. Technologies to be integrated will be selected early by the DARPA Program Manager. Evaluations of candidate technologies from a systems engineering perspective by the integrator will be essential inputs to this decision process. The reference implementations should emphasize the key innovative approaches described above.

The planned reference implementations envisioned for the program are:

R1. (4Q FY99) A configurable implementation supporting a multilayer QoS model. Baseline QoS properties include throughput, availability, and soft real-time. Group communication protocols will be accessible through a common API. Specifically, R1 will demonstrate traceable execution paths, region-based QoS management, and communications adaptivity on commercial and enhanced commercial operating systems. Configurability will be demonstrated using two different resource management systems and two different distributed object systems.

R2A. (4Q FY00) A mission-critical reference implementation incorporating initial support for the mission-critical QoS properties of hard real-time and criticality. R2A will employ adaptive resource management based on the global path concept to meet real-time and criticality constraints. Distributed real-time object support and OS support for differentiated service classes (accommodating mixed workloads of hard, soft, and non-real-time applications) and adaptation to enforce QoS constraints will be demonstrated.

R2B. (4Q FY01) An enhanced mission-critical reference implementation hardened with security, criticality, hard real-time, and time-constrained fault tolerance tradeoffs within a multidimensional QoS framework. Real-time crisis response will be demonstrated.

**(c) Evaluation:**

Reference implementations must be evaluated from a system and application level perspective to assess the scope, precision, and accuracy of QoS assurances provided. Validation of the behavior of the system under faults, security attacks, and other anomalies should be carried out in cooperation with the validation integrator (see below).

**(d) Security:**

Although security considerations are integral to many Quorum projects it is further desirable to incorporate selected advanced security concepts being developed under the High Confidence Computing Systems component of the DARPA Information

Survivability Program into the reference implementations. Technologies being developed include workflow-based authorization (Odyssey Research Associates), secure virtual enclaves (TIS), cryptographic and security service APIs (TIS), and proof-carrying code (CMU). A coherent architecture that meshes policy and authorization level technologies with OS and network level enforcement is desired. The security architecture should be compatible and interoperable with the QoS architecture.

### **2.1.2 Coordination and Architecture**

The lead integrator is expected to take the lead in coordinating the various research efforts within and across technology areas. This activity should lead to: (a) extension of the baseline QoS architecture encompassing mission-critical QoS properties; (b) definition of interfaces to promote interoperability of components and separation of concerns; (c) convergence, where appropriate, of efforts driven by similar goals or addressing different dimensions of a problem (e.g., QoS frameworks or distributed object technologies); (d) accelerate technology transfer to the specialized integration efforts.

Although not the primary focus of this activity, coordination of efforts is expected to include organization of workshops, tracking of progress on research efforts, and maintenance of web-based information collection and dissemination.

It is anticipated that the lead integrator will acquire considerable expertise, intellectual property rights, and licensing arrangements with respect to the underlying technologies. The lead integrator will be expected to transfer these capabilities to the specialized integrators so as to obviate the need for redundant acquisition or parallel arrangements.

As the Quorum program model calls for concurrently developing, integrating, and transitioning new technologies, coordination must balance the pragmatic constraints of system integration with the need to preserve a climate that fosters technical innovation, especially within the research base.

### **2.1.3 Technology Transition**

The lead integrator will mediate technology transfer to DoD activities and assist in guiding technology development by providing feedback to researchers on military requirements and technological priorities. Each of the activities cited in Section 4 (AdCon-21 and GCCS-LES) is supported by its own testbed and engineering staff. The transition role of the lead integrator will be to maintain awareness of their technology needs and schedules, perform screening, evaluation, and re-engineering (in cooperation with technology providers), and integration in preparation for rigorous testing on realistic military scenarios. This will involve close cooperation with the Defense activities including on-site assistance.

The proposal should specifically present a plan for coordinating with the AdCon-21 program. The Integrator should be prepared to support other Defense transition opportunities, including GCCS-LES, that may arise over the course of the program.

The proposal should describe a detailed plan and relevant offeror capabilities for distribution, and support of reference implementations suitable for further research and extension by the NGI and DARPA research communities and other users. The plan should reflect the anticipated modular structure of the reference implementations, with components provided by various sources. The tools, documentation, etc. that will allow such extension by research users should be described.

#### **2.1.4 Management**

Execution of the integration effort will require sound, effective management. Offerors should describe the proposed management structure, clearly identifying major roles and responsibilities (in addition to the key personnel anticipated to fill those roles), and respective levels of commitment. Consortia and teaming arrangements are encouraged to ensure that the lead integrator possess the range and depth of expertise necessary to accomplish the goals. The role, contribution, and level of commitment of each participating organization, however, must be clearly defined.

The lead integrator should possess local facilities and Internet connectivity suitable for conducting the integration, evaluation, and demonstration activities described in this solicitation.

### **2.2 Specialized Integration Activities**

The following specialized integration activities could be performed by the same or a different party as the lead integrator. All integration team participants must, however, work closely to avoid duplication of effort.

#### **2.2.1 Research Operating Systems Integration Role**

DARPA is developing several research kernels, including Fluke (U. Utah), Exokernel (MIT), and SPIN (U. Washington). In addition to the enhanced commercial OS, then, it is desirable to port and demonstrate reference implementations on one of these research operating systems. The proposals for this role should identify the research OS to be used.

Starting with the technology base selected for use by the lead integrator, this specialized integrator will insert and integrate these technologies with the research OS so as to develop reference implementations that are similar in scope to, though perhaps more experimental than, those developed by the lead integrator. Where appropriate, the exact combination of base technologies may be adjusted to take account of and exploit the novel features of the research OS. To simplify this activity, the specialized integrator should work with the lead integrator on the specification of the translucent layer API and on the transfer of the technology base from the original Quorum researchers.

#### **2.2.2 Distributed Objects Integration Role**



The Quorum program is developing QoS-aware distributed object technology. QoS is being addressed through enhancements supporting performance guarantees, real-time method invocation, access control, and object replication for availability. Specific efforts in this area include: performance/availability (BBN), real-time (WUSTL, UC-Irvine, UC-Santa Barbara), and security (TIS). The distributed objects integrator shall drive this work toward an integrated capability by overseeing the development of a common description language for specifying QoS attributes, selecting commercial and research object broker technologies to serve as a common technology base, and working with the providers to fully integrate the capabilities.

### **2.2.3 Validation Role**

The overall integration effort must explicitly address validation of the dynamic behavior of the system with respect to QoS management, dynamic adaptation, faults, and security. Such validation is not feasible unless the component technologies are designed with appropriate hooks for controllability and observability. The validation integration role will (a) work with the Quorum technology providers to insert appropriate technologies that will enhance the controllability and observability of those components in the context of a validation strategy; and (b) design and analyze experiments based on that strategy (to be conducted in cooperation with the lead integrator). Substantial validation milestones should be proposed for each of the three reference implementation stages described above. Technologies of interest include measurement and fault-injection APIs, event auditing and correlation technologies, and dynamic instrumentation. Approaches that employ or adapt existing tools and techniques are strongly encouraged; development of substantially new tools should be proposed as options.

## **3. QUORUM TECHNOLOGIES**

### **3.1 Quorum Program Organization**

Quorum requires coordinated advances across a spectrum of technologies: operating systems, middleware, languages, compilers, and networking. In particular, Quorum is specifically focused on the following major thrusts:

*Quality-of-Service Management Architecture:* Technologies for the representation, mapping, negotiation, monitoring, and maintenance of QoS “contracts”. Baseline QoS properties to be supported include throughput, availability, precision, and soft real-time constraints. Mission-critical QoS properties to be supported include hard real-time, adaptive fault tolerance, criticality (i.e., relative importance), and security.

*Drill-Down Technologies:* Technologies enabling dynamic adaptation across system layers to enforce and/or exploit application constraints. Examples include dynamic composition, code specialization, dynamic code generation, and selection of alternative mechanisms or variant implementations.

*Translucent System Layers:* Software layers and services employing drill-down technologies that may be composed and controlled through QoS APIs to establish end-to-end paths with traceable, bounded QoS characteristics. Component technologies include multithreaded runtime environments, distributed objects, communications libraries, customizable operating systems, and file systems.

*Adaptive Global Resource Management:* Technologies for the dynamic discovery and allocation of resources driven by application QoS demands and economic models. This thrust encompasses technologies for the characterization of resource capabilities, dynamic collection and dissemination of status information, and near-optimal allocation. Advanced technologies for adaptive re-allocation and/or the dynamic adjustment of the QoS contract in response to workload variations, failures, or information warfare attacks are also being developed.

### **3.2 Research in Progress**

The integration effort will be expected to demonstrate the following key technical approaches being pursued by Quorum researchers in support of the program's goals.

*Traceable Execution Paths:* Establishing end-to-end QoS requires traceability of resource requirements through software layers and across nodes. At a minimum, service invocations, system calls, and I/O operations must be associated with the application threads on whose behalf they execute. This traceability permits integrated optimization of paths comprising computing and communication operations through mechanisms such as upcalls, message-driven scheduling, and migrating threads. Projects include network I/O tracing (Sarnoff), RPC-based distributed threads (Open Group), Scout OS (Arizona), message-driven scheduling (UIUC, ISI), and real-time upcalls (WUSTL).

*Global Paths:* Many military applications exhibit a pipeline structure that can be exploited to greatly simplify the dynamic resource allocation problem. End-to-end QoS constraints can be decomposed into constraints on computing, communications, and I/O resources along a chain rather than addressing the resource allocation problem in its full generality. The picture is complicated, however, by the fact that applications may possess a multi-pipeline structure and some tasks may be realized as fault-tolerant process groups. Also, allocation and adaptive reallocation often must occur within real-time constraints. Projects include Desiderata (U. Texas, Arlington), Adaptive Resource Management (Honeywell), and Adaptive QoS-Driven Resource Management for Distributed Real-Time Systems (SRI).

*Region-Based QoS Management:* In this paradigm, application expectations are partitioned into a small number of operating regimes, each of which is defined as a contiguous region in a multi-dimensional space representing resource availability (e.g., bandwidth, latency, and processing power) and quality parameters (e.g., precision, reliability, confidentiality). Adaptation is triggered by transitions between regions, ultimately renegotiating expectations if lower-level mechanisms cannot be invoked to return the system to the desired region. Projects include QoS for Objects (BBN), EPIQ (UIUC), and Adaptive Resource Management (Honeywell).

*Feedback Control:* The feedback control paradigm is being explored for management of QoS. Technologies are being developed for real-time monitoring of the application and system state, filtering/smoothing of data, detection and prediction of QoS region transitions, and adaptation decision mechanisms to ensure stability. Projects include Adaptive Resource Management (Honeywell), Systemic QoS (OGI), and MSHN (Naval Postgraduate School).

*Variant Generation, Selection, and Composition:* A fundamental method for achieving adaptation is the efficient switching among different algorithms or implementations. Several approaches are being developed for the automated generation and/or selection of these variants: code specialization and replugging (Synthetix, OGI), OS extensions (SPIN, U. Washington), multi-method communication (Nexus, ISI), microprotocol composition (Cactus, U. Arizona), and Quality of Service for Objects (QuO, BBN).

*Service Class Differentiation:* Assured service at the OS and network levels is facilitated through strict control of the level and timing of resource consumption allowing simultaneous support for multiple service classes. Example technologies include multi-level scheduling accommodating mixed workloads of hard, soft, and non-real-time applications (CMU, UIUC, Utah), nested virtual machines supporting hierarchical resource management (Utah), resource reserve sets (CMU), and heterogeneous packet flows (UIUC).

*Adaptive Applications:* If QoS expectations cannot be met at lower layers, applications must adjust their demands in a manner that ensures the success of the mission albeit with degraded precision or accuracy. While such adaptation is generally application-specific, Quorum is developing a small number of useful paradigms, including the imprecise computation model (UIUC) and software feedback (OGI).

The relationship of the above technical approaches to the Quorum thrusts is summarized in the table below:

	<b>QoS Arch.</b>	<b>Drill Down</b>	<b>Trans-lucent</b>	<b>Global RM</b>
<b>Traceable Paths</b>		<b>x</b>		
<b>Global Paths</b>				<b>x</b>
<b>QoS Regions</b>	<b>x</b>		<b>x</b>	
<b>Feedback</b>	<b>x</b>		<b>x</b>	<b>x</b>
<b>Variants</b>		<b>x</b>	<b>x</b>	
<b>Differentiation</b>	<b>x</b>	<b>x</b>		<b>x</b>
<b>Adaptive Apps</b>	<b>x</b>			

Integration activities are further expected to leverage other selected technologies from related DARPA programs, as necessary to meet program goals and customer needs. In particular, the High Confidence Computing Systems component of the Information Survivability program is developing technologies in the following areas supportive of mission critical requirements: secure and real-time operating systems, adaptive group communications, and secure distributed environments.

#### **4. QUORUM TRANSITION TARGETS**

The following three classes of activities have been identified as targets of the Quorum integration effort:

##### **4.1 Defense Activities**

The Quorum vision is a common distributed environment capable of spanning the tactical and strategic domains facilitating seamless integration of situation awareness, planning, and combat control. This vision is reflected in the current transition targets: the Advanced Control 21st Century Surface Combatant (AdCon-21) program at the Naval Surface Warfare Center, Dahlgren Division, and the Global Command and Control System Leading Edge Services (GCCS-LES) program at the DARPA/DISA Advanced Information Technology Services Joint Program Office (AITS-JPO).

AdCon-21 is developing a common engineering base (CEB) for shipboard computing systems based on a totally distributed architecture. Requirements for hard real-time quality of service, fault tolerance, adaptive resource management, and security will rely critically on accelerated insertion and evaluation of Quorum technologies to meet the AdCon-21 schedule. The AdCon-21 architecture is initially targeting various platforms, including the 21st Century Surface Combatant (SC-21) and CVX (aircraft carrier). The AdCon-21 CEB must support integration of combat control and C4I capabilities; cooperative engagement, e.g., through distribution of functionality across a battle group; and non-combat support functions such as ship control, and logistics, and power management.

The GCCS-LES is integrating a variety of advanced command and control services and applications into a CORBA-based reference architecture originally developed under the Joint Task Force Advanced Technology Demonstration (JTF ATD). Quorum technologies could enhance this architecture with end-to-end QoS management, real-time support, object migration, dynamic resource management, and crisis management.

## **4.2 Next Generation Internet (NGI)**

Quorum technologies are central to the NGI vision. Widespread deployment on the NGI high performance and ultra high performance internetworks will promote experimentation and development of advanced applications in a variety of disciplines by the NGI research community.

## **4.3 Commercial Technology Transfer and Standards**

Affordability is driving the DoD toward increased reliance on open standards and commercial off-the-shelf technology (COTS). To be regarded as successful, Quorum technologies must not only solve the technical challenges they address, but must also eventually be available as modular, composable, configurable, components from a commercially sustainable technology base. The integration effort must therefore ensure that technologies are appropriately “packaged” to facilitate commercialization; conduct convincing evaluations and demonstrations of Quorum capabilities; actively engage vendors to accelerate broad commercial transition; and actively participate in relevant standards activities.

# **5. BACKGROUND INFORMATION**

Background information relevant to this solicitation is available through an outreach briefing and on the World-Wide Web.

## **5.1 Outreach Briefing**

An outreach briefing for the Quorum Integration component of DARPA BAA 98-02 will be held on October 31, 1997. Information regarding the time and location of the briefing as well as registration instructions may be obtained from the administrative contact below. The intent of this briefing is to provide information regarding the BAA and to answer clarifying questions. Clarifying questions can be submitted in advance to the administrative address provided below. Remarks and explanations provided at this meeting shall not qualify the terms of the BAA. The terms and specifications of the BAA remain unchanged unless the BAA is amended in writing by DARPA.

A copy of the briefing presentation slides, summarized questions and answers resulting from the meeting, and a briefing attendee list will be available after the briefing at URL <http://www.ito.darpa.mil/Solicitations.html> or by contacting the administrative contact.

## 5.2 World-Wide Web

Background information relevant to this solicitation is available on the World-Wide Web. Proposers are reminded, however, that the *Commerce Business Daily* announcement in conjunction with the pamphlets BAA 98-02 Proposer Information - Network Engineering; BAA 98-02 Proposer Information - Quorum; and BAA 98-02 Proposer Information - SuperNet, constitutes the total BAA.

DARPA/ITO Quorum Program

<http://www.ito.darpa.mil/ResearchAreas.html>

DARPA/ITO Information Survivability Program (High Confidence Computing Systems subprogram)

<http://www.ito.darpa.mil/ResearchAreas.html>

Advanced Control 21st Century Surface Combatant

<http://SC21.crane.navy.mil>

Next Generation Internet (NGI)

<http://www.ngi.gov>

DARPA/DISA Advanced Information Technology Services Joint Program Office (AITS-JPO)

<http://www.les.mil>

### **PROGRAM SCOPE:**

Proposals should not exceed forty (40) months in length. One lead integrator award is anticipated. Contract award is expected to be made in the second half of Fiscal Year 1998.

Proposed research should investigate innovative approaches and techniques that lead to or enable revolutionary advances in the state-of-the-art. Research should result in prototype hardware and software demonstrating integrated concepts and approaches on Defense-relevant applications. Partnering arrangements among non-profit research organizations and industry are strongly encouraged.

### **SUBMISSION PROCESS:**

Proposers are strongly encouraged to submit a proposal abstract in advance of actual proposals. This procedure is intended to minimize unnecessary effort in proposal preparation and review. An original and eight (8) copies of the proposal abstract must be submitted to DARPA/ITO, ATTN: BAA 98-02, 3701 North Fairfax Drive, Arlington, VA 22203-1714, in time to reach DARPA by 4:00 PM (ET), Monday, November 10, 1997, to guarantee review. An original and eight (8) copies of each proposal must be submitted to the administrative address for this BAA in time to reach DARPA by 4:00

PM (ET) Thursday, December 18, 1997, in order to be considered. DARPA will acknowledge receipt of submissions and assign control numbers that should be used in all further correspondence regarding abstracts and proposals.

DARPA will attempt to review proposal abstracts within 21 days after receipt and will make a recommendation encouraging or discouraging formal proposal submissions. Proposal abstracts will be reviewed as they are received. Early submissions are strongly encouraged. Regardless of the recommendation, the decision to propose is the responsibility of the proposer. All submitted proposals will be fully reviewed regardless of the disposition of the proposal abstract.

Restrictive notices notwithstanding, proposals may be handled, for administrative purposes only, by a support contractor. This support contractor is prohibited from competition in DARPA technical research and is bound by appropriate non-disclosure requirements. All proposals will be reviewed by Government officials only.

## **EVALUATION AND FUNDING PROCESSES:**

Proposals will not be evaluated against each other since they are not submitted in accordance with a common work statement. DARPA's intent is to review proposals as soon as possible after they arrive; however, proposals may be reviewed periodically for administrative reasons. For evaluation purposes, a proposal is the document described in PROPOSAL FORMAT (see below). Other supporting or background materials submitted with the proposal will be considered for the reviewer's convenience only and not considered as part of the proposal.

Evaluation of proposals will be accomplished through a scientific review of each proposal using the following criteria, which are listed in descending order of relative importance:

- (1) overall scientific and technical merit,
- (2) potential contribution and relevance to DARPA mission,
- (3) offeror's capabilities and related experience,
- (4) plans and capability to accomplish technology transition, and
- (5) cost realism.

As soon as the proposal evaluation is completed, the proposer will be notified of selectability or non-selectability. Selectable proposals will be considered for funding; non-selectable proposals will be destroyed. (One copy of non-selectable proposals may be retained for filing purposes.) Not all proposals deemed selectable will be funded. Decisions to fund selectable proposals will be based on funds available, scientific and technical merit, and potential contribution and relevance to DARPA's mission. DARPA may retain some selectable proposals for a period of up to one year in order to reconsider those proposals for funding. Submitters of those retained proposals will receive notification to that effect.

The Government reserves the right to select for award all, some, or none of the proposals received. Proposals identified for funding may result in a contract, grant, cooperative agreement, or other transaction depending upon the nature of the work proposed, the required degree of interaction between parties, and other factors. If warranted, portions of resulting awards may be segregated into pre-priced options.

It is anticipated that a highly flexible acquisition vehicle, such as an Indefinite Deliverables, Indefinite Quantity (IDIQ) contract, will be necessary to implement this effort. This will allow efficient direction of available funding to priorities within the broad scope of the integration effort outlined in this solicitation and timely exploitation of technological and transition opportunities.

#### **GENERAL INFORMATION:**

Proposals not meeting the format described in this pamphlet may not be reviewed. Proposals and proposal abstracts may not be submitted by fax; any so sent will be disregarded. The *Commerce Business Daily* notice, in conjunction with the pamphlets BAA 98-02 Proposer Information - Network Engineering; BAA 98-02 Proposer Information - Quorum; and BAA 98-02 Proposer Information - SuperNet, constitutes the total BAA. No additional information is available, nor will a formal RFP or other solicitation regarding this announcement be issued. Requests for same will be disregarded. All responsible sources capable of satisfying the Government's needs may submit a proposal that shall be considered by DARPA. Historically Black Colleges and Universities (HBCU) and Minority Institutions (MI) are encouraged to submit proposals and join others in submitting proposals. However, no portion of this BAA will be set aside for HBCU and MI participation due to the impracticality of reserving discrete or severable areas of this research for exclusive competition among these entities.

#### **PROPOSAL ABSTRACT FORMAT:**

Proposal abstracts are encouraged in advance of full proposals in order to provide potential offerors with a rapid response and to minimize unnecessary effort. The abstract submission should be clearly marked "PROPOSAL ABSTRACT" and should include a cover sheet and a technical section.

The cover sheet should include: (1) BAA number; (2) Proposed integration role from among the following: "LEAD INTEGRATOR ROLE," "RESEARCH OPERATING SYSTEMS INTEGRATION ROLE," "DISTRIBUTED OBJECTS INTEGRATION ROLE," or "VALIDATION ROLE"; (3) Proposal abstract title; (4) Technical point of contact including: name, telephone number, electronic mail address, fax (if available) and mailing address; (5) Administrative point of contact including: name, telephone number, electronic mail address, fax (if available) and mailing address; (6) List of key personnel; (7) Summary of the costs of the proposed research, including total base cost, estimates of base cost in each year of the effort, estimates of itemized options in each year of the effort, and cost sharing if relevant; and (8) Contractor's type of business, selected from among the following categories: "LARGE BUSINESS," "SMALL DISADVANTAGED



BUSINESS," "OTHER SMALL BUSINESS," "HBCU," "MI," "OTHER EDUCATIONAL," or "OTHER NONPROFIT." The cover sheet is limited to one page.

The technical section of the abstract should include the following: A. {1 page} Innovative claims for the proposed research. This page is the centerpiece of the abstract and should succinctly describe the unique proposed contribution; and B. {4 pages} Technical rationale, technical approach and constructive plan for accomplishment of technical goals in support of innovative claims and deliverable products. Include comparison with other ongoing research indicating advantages and disadvantages of the proposed effort.

The total length of the abstract should not exceed six pages including the cover sheet. Abstracts only (not full proposals) may be submitted via electronic mail to baa98-02@darpa.mil. E-mail submissions must be formatted as plain ASCII, 72 characters to the line, 60 lines to the page. This is the only electronic format that will be accepted. No formal transmittal letter is required.

## **PROPOSAL FORMAT:**

Proposals shall include the following sections, each starting on a new page (where a "page" is 8-1/2 by 11 inches with type not smaller than 12 point) and with text on one side only. The submission of other supporting materials along with the proposal is strongly discouraged. Sections I and II of the proposal shall not exceed 41 pages. Maximum page lengths for each section are shown in braces { } below.

### **Section I. Administrative**

{1} Cover Page including: (1) BAA number; (2) Proposed integration role from among the following: "LEAD INTEGRATOR ROLE," "RESEARCH OPERATING SYSTEMS INTEGRATION ROLE," "DISTRIBUTED OBJECTS INTEGRATION ROLE," or "VALIDATION ROLE" (3) Proposal abstract title; (4) Technical point of contact including: name, telephone number, electronic mail address, fax (if available) and mailing address; (5) Administrative point of contact including: name, telephone number, electronic mail address, fax (if available) and mailing address; (6) Summary of the costs of the proposed research, including total base cost, estimates of base cost in each year of the effort, estimates of itemized options in each year of the effort, and cost sharing if relevant; and (7) Contractor's type of business, selected from among the following categories: "LARGE BUSINESS," "SMALL DISADVANTAGED BUSINESS," "OTHER SMALL BUSINESS," "HBCU," "MI," "OTHER EDUCATIONAL," or "OTHER NONPROFIT."

### **Section II. Detailed Proposal Information**

This section provides the detailed discussion of the proposed work necessary to enable an in-depth review of the specific technical and managerial issues. Specific attention must

be given to addressing both risk and payoff of the proposed work that make it desirable to DARPA.

- A. {1} Innovative claims for the proposed research. This page is the centerpiece of the proposal and should succinctly describe the unique proposed contribution.
- B. {17} Technical rationale, technical approach and constructive management plan for accomplishment of technical goals in support of innovative claims and deliverable products. This section should include detailed plans for the following activities (1) Integration and Evaluation, (2) Coordination and Architecture, and (3) Technology Transition to DoD and NGI activities.
- C. {2} Deliverables associated with the proposed research. Include in this section all proprietary claims to results, prototypes, or systems supporting and/or necessary for the use of the research, results, and/or prototype. If there are no proprietary claims, this should be stated. The offeror must submit a separate list of all technical data or computer software that will be furnished to the Government with other than unlimited rights (see DFARS 227.)
- D. {3} Statement of Work (SOW) written in plain English, outlining the scope of the effort and citing specific tasks to be performed and specific contractor requirements.
- E. {2} Schedule of milestones for the proposed research.
- F. {3} Technology Transfer. Description of the transferable technology and expected technology transfer path. This section should specifically emphasize the path for commercialization of Quorum, as opposed to coordination with DoD and NGI activities (see Section II.B).
- G. {2} Comparison with other ongoing research indicating advantages and disadvantages of the proposed effort.
- H. {4} List of key personnel, concise summary of their qualifications, and discussion of proposer's previous accomplishments and work in this or closely related research areas. Indicate the level of effort to be expended by each person during each contract year, their principal responsibilities in the effort, and other (current and proposed) major sources of support for them and/or commitments of their efforts.
- I. {1} Description of the facilities that would be used for the proposed effort.
- J. {5} Cost by task, with breakdown into accounting categories and equipment for the entire contract and for each contract year. Where the effort consists of multiple portions that could reasonably be partitioned for purposes of funding, these should be identified as contract options with separate cost estimates for each. Since an IDIQ contract may be used, the cost proposal should address the cost ceiling on the entire proposed effort as well as the base effort and options.

Awards made under this BAA may be subject to the provisions of the Federal Acquisition Regulation (FAR) Subpart 9.5, Organizational Conflict of Interest. All offerors and proposed subcontractors must affirmatively state whether they are supporting any DARPA technical office(s) through an active contract or subcontract. "Support contract" or "support contractor" includes a contract or subcontract for acquisition of System Engineering and Technical Assistance (SETA) services, and other support service contracts in which any one of the following situations apply: have personnel who regularly maintain offices or frequently occupy space within DARPA; maintain external spaces in which DARPA personnel maintain offices or frequently occupy; or have personnel with any access to the DARPA fiscal database, EIS, or contractual or programmatic documentation related to other than their own contract(s). All affirmations must state which office(s) the offeror supports, and identify the prime contract number. Affirmations should be furnished at the time of proposal submission. All facts relevant to the existence or potential existence of organizational conflicts of interest, as that term is defined in FAR 9.501, must be disclosed in Section II., H of the proposal, organized by task and year. This disclosure shall include a description of the action the Contractor has taken, or proposes to take, to avoid, neutralize, or mitigate such conflict.

### **Section III. Additional Information**

A bibliography of relevant technical papers and research notes (published and unpublished) that document the technical ideas upon which the proposal is based. Copies of not more than three relevant papers may be included in the proposal submission; provide one set for the original proposal and one set for each of the eight proposal copies. Please note: the materials listed in Section III. Additional Information, and submitted with the proposal, will be considered for the reviewer's convenience only and not considered as part of the proposal for evaluation purposes.

#### **The administrative addresses for this BAA are:**

Fax: 703-522-7161 Addressed to: DARPA/ITO, BAA 98-02  
Electronic Mail: baa98-02@darpa.mil  
Electronic File Retrieval: <http://www.ito.darpa.mil/Solicitations.html>  
Mail: DARPA/ITO  
ATTN: BAA 98-02  
3701 North Fairfax Drive  
Arlington, VA 22203-1714

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## **BAA 98-02 PROPOSER INFORMATION PAMPHLET 3 SUPERNET**

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The Defense Advanced Research Projects Agency (DARPA) often selects its research efforts through the Broad Agency Announcement (BAA) process. The BAA will appear first in the *Commerce Business Daily*, published by the U.S. Government, Department of Commerce. The following information is for those wishing to respond to the Broad Agency Announcement.

**NEXT GENERATION INTERNET: SUPERNET SOL BAA 98-02 DUE 12/18/97**  
**POC Dr. Bertram Hui, DARPA/ITO, FAX: (703) 522-7161.**

**BACKGROUND:**

The Next Generation Internet (NGI) initiative will develop novel network capabilities to enable a new wave of revolutionary applications. DARPA's role in NGI will involve: experimental research for advanced network technologies; and the development of ultra-high speed switching and transmission technologies that lay the ground work for terabit per second (Tb/s) networks. The former activity will be organized into two components referred to as Network Engineering and Quorum. The latter is referred to as SuperNet. This Proposer Information Pamphlet (PIP) describes solicitation information only for SuperNet. Network Engineering and Quorum are described in separate Proposer Information Pamphlets.

The objective of SuperNet is to develop ultra-high speed multiplexing and transmission technologies together with advanced configuration management and control capabilities, and to demonstrate end-to-end network connectivity involving tens of sites (nodes) and advanced applications. Attainment of this goal, together with the technologies developed in NGI Networking Engineering and Quorum, will be the pathway to terabit per second networks, supported by the appropriate network management and control function, with assured end-to-end service.

The following are technical topic areas for SuperNet:

**(1) WIDE AREA BROADBAND CORE:** This topic addresses technologies and networking at the physical layer. It is DARPA's intention that one or more metropolitan networks with links capable of at least 40 Gb/s transmission rates be deployed. In addition, some or all of the metropolitan networks will be connected to form a national ultra high capacity network.

The network elements in these networks will be largely all-optical with no electronic conversion. Examples of network elements under consideration include wavelength add-drop multiplexers and wavelength cross-connects with and without wavelength conversion. Some network elements may be fully reconfigurable (the capability of switching arbitrary wavelength from any input port to any output port) to demonstrate the flexibility of WDM technology, and other network elements may have fixed configuration. The intention is to demonstrate interoperability among network elements

with a diversity of features and capabilities. Interoperability among network elements includes (but is not limited to) signaling to enable the setup of switched virtual circuits and fault recovery/restoration at the physical layer. The network elements to be developed in this technical area should include appropriate monitors and interfaces to permit their integration with the upper layers in the protocol stacks (see the Network Engineering PIP). These elements will also have the appropriate interfaces to connect to customer premise and campus networks, and will support the necessary wavelength, signal and timing matching, and synchronization functions.

DARPA solicits proposals, from telecommunication carriers and other qualified sources, to make “dark fibers” or “dark wavelength” channels available to selected DARPA sponsored researchers, on a collaborative and experimental basis. These facilities, which may terminate at researcher premises and/or carrier premise collocation points, should be configured in MAN and/or WAN topologies and suitable for the experimental use and evaluation of network elements, including transmitters and multiplexers, and network management technologies. Proposals to develop research prototypes of the appropriate elements for the above network are also sought. An anticipated result is a research partnership in which the selected carriers, vendors, researchers, and the DoD program management team will collaborate on the development of this NGI apparatus and share in the experimental results and operational expertise derived from its commissioning and use.

Teaming or consortium based arrangements are strongly encouraged, and teams may involve a system integrator, service providers, equipment vendors, research institutions and network management software providers. Since the eventual network will cross over multiple domains operated by different carriers, interoperability among network elements and management software in a collocation environment will be an important consideration. Furthermore, participants in this topic area will be expected to work with other NGI researchers and, in particular, to incorporate results developed in the Quorum and Network Engineering topic areas, as they become available.

**(2) TB/S MULTIPLEXING AND SWITCHING:** DARPA will develop generation-after-next multiplexing, buffering, synchronization and switching technologies scalable to a Tb/s packet network. Instead of concentrating on scaling up the capacity of a single switching system that could be subject to frequent and high impact failure, innovative ways are sought to achieve the switching function in a distributed manner, for example, by arranging for packet-based traffic to be dynamically deflected on to available wavelengths of a hybrid switching system.

Technologies to be developed in this area could include: intelligent multiplexers, demultiplexers, switches and/or routers that bridge the electronic and optical domains; and overall architectural concepts and distributed control mechanisms. This topic also seeks innovative protocols to bypass the intermediate protocol stacks and directly route IP packets on WDM channels. Some of the issues to be addressed are: impact on interoperation between IP and WDM, resource allocation, scalability, overall performance and system implications.

This topic area also solicits innovative ideas to develop and prototype ultra-fast TDM components and systems capable of packet transmission, switching, buffering, and synchronization at 500 Gb/s and eventually at Tb/s. Proposals should describe the means by which multiple packet sources with varying characteristics are groomed onto the shared optical channels. The prototype network should be able to deliver variable bit rate services ranging from bandwidth-on-demand to consistent and assured service. Of particular interest are: technologies to support ultra-fast TDM operation over conventional fibers and in conjunction with WDM technology; and novel approaches to optical based packet buffering.

**(3) BROADBAND LOCAL TRUNKING:** This topic solicits proposals to deliver bursty services to high end users on a cost-effective basis. DoD has a pressing need to provide selected sites with “orders of magnitude above average” access to the network core. A recurring source of delay in the commissioning of advanced research facilities is the lack of a cost effective approach to deliver broadband access to high end users while sharing the access network with common users.

Proposed access strategies should permit near transparent and service-independent connectivity between customer premises and the all-optical backbone, notwithstanding the need to traverse electronic components in the local access network. Proposals in this technical topic area could include ultra fast fiber based access at 20-40 Gb/s rates or Gb/s RF (including satellite) trunking. The latter may be particularly cost effective in accessing remote and/or rural locations of importance to the DoD.

#### **ADDITIONAL INFORMATION:**

Information regarding NGI may be found at URL: <http://www.ngi.gov>. This reference is provided for information purposes only and is not considered an official part of this specific solicitation. The information presented at this web site is occasionally updated without notification.

#### **PROGRAM SCOPE:**

Proposed research should investigate innovative approaches and techniques that lead to or enable revolutionary advances in the state-of-the-art. Research should result in prototype hardware and software demonstrating integrated concepts and approaches on Defense-relevant applications. Specifically excluded is research that primarily results in evolutionary improvement to the existing state of practice or focuses on a specific system or hardware solution. Integrated solution sets embodying significant technological advances are strongly encouraged over narrowly defined research endeavors. Partnering arrangements among academic, industrial, and non-profit research organizations are strongly encouraged.

In recognition of the unique opportunity to participate in the development of novel network technologies and applications, it is anticipated that proposals will incorporate extensive cost sharing arrangements, especially in the area of fiber facilities.

Proposals for individual efforts should not exceed three years in length. Contract awards are expected to be made during the second half of 1998. Multiple awards are anticipated. Technologies that have a broad impact on military capability will be given highest priority. Proposals that address multiple areas in an integrated fashion are encouraged. Proposals that incorporate both technology development and demonstration are encouraged. Demonstrations should be aimed at motivating and/or validating technology development and not as stand-alone demonstrations. Collaborative university/industry research and development is desirable to ensure technology transfer. Teaming arrangements and cost sharing are encouraged where appropriate, especially when coupling technology developments to applications demonstrations.

#### **SUBMISSION PROCESS:**

Proposers are strongly encouraged to submit a proposal abstract in advance of actual proposals. This procedure is intended to minimize unnecessary effort in proposal preparation and review. An original and eight (8) copies of the proposal abstract must be submitted to DARPA/ITO, ATTN: BAA 98-02, 3701 North Fairfax Drive, Arlington, VA 22203-1714, in time to reach DARPA by 4:00 PM (ET), Monday, November 10, 1997, to guarantee review. An original and eight (8) copies of each proposal must be submitted to the administrative address for this BAA in time to reach DARPA by 4:00 PM (ET) Thursday, December 18, 1997, in order to be considered. DARPA will acknowledge receipt of submissions and assign control numbers that should be used in all further correspondence regarding abstracts and proposals.

DARPA will attempt to review proposal abstracts within 21 days after receipt and will make a recommendation encouraging or discouraging formal proposal submissions. Proposal abstracts will be reviewed as they are received. Early submissions are strongly encouraged. Regardless of the recommendation, the decision to propose is the responsibility of the proposer. All submitted proposals will be fully reviewed regardless of the disposition of the proposal abstract.

Restrictive notices notwithstanding, proposals may be handled, for administrative purposes only, by a support contractor. This support contractor is prohibited from competition in DARPA technical research and is bound by appropriate non-disclosure requirements. All proposals will be reviewed by Government officials only.

#### **EVALUATION AND FUNDING PROCESSES:**

Proposals will not be evaluated against each other since they are not submitted in accordance with a common work statement. DARPA's intent is to review proposals as soon as possible after they arrive; however, proposals may be reviewed periodically for administrative reasons. For evaluation purposes, a proposal is the document described in

PROPOSAL FORMAT (see below). Other supporting or background materials submitted with the proposal will be considered for the reviewer's convenience only and not considered as part of the proposal.

Evaluation of proposals will be accomplished through a scientific review of each proposal using the following criteria, which are listed in descending order of relative importance:

- (1) overall scientific and technical merit,
- (2) potential contribution and relevance to DARPA mission,
- (3) offeror's capabilities and related experience,
- (4) plans and capability to accomplish technology transition, and
- (5) cost realism.

As soon as the proposal evaluation is completed, the proposer will be notified of selectability or non-selectability. Selectable proposals will be considered for funding; non-selectable proposals will be destroyed. (One copy of non-selectable proposals may be retained for filing purposes.) Not all proposals deemed selectable will be funded. Decisions to fund selectable proposals will be based on funds available, scientific and technical merit, and potential contribution and relevance to DARPA's mission. DARPA may retain some selectable proposals for a period of up to one year in order to reconsider those proposals for funding. Submitters of those retained proposals will receive notification to that effect.

The Government reserves the right to select for award all, some, or none of the proposals received. Proposals identified for funding may result in a contract, grant, cooperative agreement, or other transaction depending upon the nature of the work proposed, the required degree of interaction between parties, and other factors. If warranted, portions of resulting awards may be segregated into pre-priced options.

#### **GENERAL INFORMATION:**

A pre-proposal briefing will be held on Friday, October 31, 1997. Contact one of the administrative addresses below for details regarding time, location, and registration information. The intent of this briefing is to provide information regarding the BAA and to answer clarifying questions. Clarifying questions can be submitted in advance to the administrative address provided below. Remarks and explanations provided at this meeting shall not qualify the terms of the BAA. The terms and specifications of the BAA remain unchanged unless the BAA is amended in writing by DARPA.

A copy of the briefing presentation slides, summarized questions and answers resulting from the meeting, and a briefing attendee list will be available after the briefing at URL <http://www.ito.darpa.mil/Solicitations.html> or by contacting the administrative contact.

Proposals not meeting the format described in this pamphlet may not be reviewed. Proposals and proposal abstracts may not be submitted by fax; any so sent will be disregarded. The *Commerce Business Daily* notice, in conjunction with the pamphlets



BAA 98-02 Proposer Information - Network Engineering; BAA 98-02 Proposer Information - Quorum; and BAA 98-02 Proposer Information - SuperNet, constitutes the total BAA. No additional information is available, nor will a formal RFP or other solicitation regarding this announcement be issued. Requests for same will be disregarded. All responsible sources capable of satisfying the Government's needs may submit a proposal that shall be considered by DARPA. Historically Black Colleges and Universities (HBCU) and Minority Institutions (MI) are encouraged to submit proposals and join others in submitting proposals. However, no portion of this BAA will be set aside for HBCU and MI participation due to the impracticality of reserving discrete or severable areas of this research for exclusive competition among these entities.

#### **PROPOSAL ABSTRACT FORMAT:**

Proposal abstracts are encouraged in advance of full proposals in order to provide potential offerors with a rapid response and to minimize unnecessary effort. The abstract submission should be clearly marked "PROPOSAL ABSTRACT" and should include a cover sheet and a technical section.

The cover sheet should include: (1) BAA number; (2) Technical topic area; (3) Proposal title; (4) Technical point of contact including: name, telephone number, electronic mail address, fax (if available) and mailing address; (5) Administrative point of contact including: name, telephone number, electronic mail address, fax (if available) and mailing address; (6) List of key personnel; (7) Summary of the costs of the proposed research, including total base cost, estimates of base cost in each year of the effort, estimates of itemized options in each year of the effort, and cost sharing if relevant; and (8) Contractor's type of business, selected from among the following categories: "LARGE BUSINESS," "SMALL DISADVANTAGED BUSINESS," "OTHER SMALL BUSINESS," "HBCU," "MI," "OTHER EDUCATIONAL," or "OTHER NONPROFIT." The cover sheet is limited to one page.

The technical section of the abstract should include the following: A. {1 page} Innovative claims for the proposed research. This page is the centerpiece of the abstract and should succinctly describe the unique proposed contribution; and B. {4 pages} Technical rationale, technical approach and constructive plan for accomplishment of technical goals in support of innovative claims and deliverable products. Include comparison with other ongoing research indicating advantages and disadvantages of the proposed effort.

The total length of the abstract should not exceed six pages including the cover sheet. Abstracts only (not full proposals) may be submitted via electronic mail to baa98-02@darpa.mil. E-mail submissions must be formatted as plain ASCII, 72 characters to the line, 60 lines to the page. This is the only electronic format that will be accepted. No formal transmittal letter is required.

#### **PROPOSAL FORMAT:**

Proposals shall include the following sections, each starting on a new page (where a "page" is 8-1/2 by 11 inches with type not smaller than 12 point) and with text on one side only. The submission of other supporting materials along with the proposal is strongly discouraged. Sections I and II of the proposal shall not exceed 41 pages. Maximum page lengths for each section are shown in braces { } below.

## **Section I. Administrative**

{1} Cover Page including: (1) BAA number; (2) Technical topic area; (3) Proposal title; (4) Technical point of contact including: name, telephone number, electronic mail address, fax (if available) and mailing address; (5) Administrative point of contact including: name, telephone number, electronic mail address, fax (if available) and mailing address; (6) Summary of the costs of the proposed research, including total base cost, estimates of base cost in each year of the effort, estimates of itemized options in each year of the effort, and cost sharing if relevant; and (7) Contractor's type of business, selected from among the following categories: "LARGE BUSINESS," "SMALL DISADVANTAGED BUSINESS," "OTHER SMALL BUSINESS," "HBCU," "MI," "OTHER EDUCATIONAL," or "OTHER NONPROFIT."

## **Section II. Detailed Proposal Information**

This section provides the detailed discussion of the proposed work necessary to enable an in-depth review of the specific technical and managerial issues. Specific attention must be given to addressing both risk and payoff of the proposed work that make it desirable to DARPA.

- A. {1} Innovative claims for the proposed research. This page is the centerpiece of the proposal and should succinctly describe the unique proposed contribution.
- B. {18} Technical rationale, technical approach and constructive plan for accomplishment of technical goals in support of innovative claims and deliverable products.
- C. {2} Deliverables associated with the proposed research. Include in this section all proprietary claims to results, prototypes, or systems supporting and/or necessary for the use of the research, results, and/or prototype. If there are no proprietary claims, this should be stated. The offeror must submit a separate list of all technical data or computer software that will be furnished to the Government with other than unlimited rights (see DFARS 227.)
- D. {3} Statement of Work (SOW) written in plain English, outlining the scope of the effort and citing specific tasks to be performed and specific contractor requirements.
- E. {1} Schedule of milestones for the proposed research.

- F. {2} Technology Transfer. Description of the transferable technology and expected technology transfer path.
- G. {3} Comparison with other ongoing research indicating advantages and disadvantages of the proposed effort.
- H. {4} List of key personnel, concise summary of their qualifications, and discussion of proposer's previous accomplishments and work in this or closely related research areas. Indicate the level of effort to be expended by each person during each contract year and other (current and proposed) major sources of support for them and/or commitments of their efforts.
- I. {1} Description of the facilities that would be used for the proposed effort.
- J. {5} Cost by task, with breakdown into accounting categories and equipment for the entire contract and for each contract year. Where the effort consists of multiple portions that could reasonably be partitioned for purposes of funding, these should be identified as contract options with separate cost estimates for each. Details of any cost sharing should also be included.

Awards made under this BAA may be subject to the provisions of the Federal Acquisition Regulation (FAR) Subpart 9.5, Organizational Conflict of Interest. All offerors and proposed subcontractors must affirmatively state whether they are supporting any DARPA technical office(s) through an active contract or subcontract. "Support contract" or "support contractor" includes a contract or subcontract for acquisition of System Engineering and Technical Assistance (SETA) services, and other support service contracts in which any one of the following situations apply: have personnel who regularly maintain offices or frequently occupy space within DARPA; maintain external spaces in which DARPA personnel maintain offices or frequently occupy; or have personnel with any access to the DARPA fiscal database, EIS, or contractual or programmatic documentation related to other than their own contract(s). All affirmations must state which office(s) the offeror supports, and identify the prime contract number. Affirmations should be furnished at the time of proposal submission. All facts relevant to the existence or potential existence of organizational conflicts of interest, as that term is defined in FAR 9.501, must be disclosed in Section II., H of the proposal, organized by task and year. This disclosure shall include a description of the action the Contractor has taken, or proposes to take, to avoid, neutralize, or mitigate such conflict.

### **Section III. Additional Information**

A bibliography of relevant technical papers and research notes (published and unpublished) that document the technical ideas upon which the proposal is based. Copies of not more than three relevant papers may be included in the proposal submission; provide one set for the original proposal and one set for each of the eight proposal copies. Please note: the materials listed in Section III. Additional Information, and submitted

with the proposal, will be considered for the reviewer's convenience only and not considered as part of the proposal for evaluation purposes.

**The administrative addresses for this BAA are:**

Fax: 703-522-7161 Addressed to: DARPA/ITO, BAA 98-02

Electronic Mail: baa98-02@darpa.mil

Electronic File Retrieval: <http://www.ito.darpa.mil/Solicitations.html>

Mail: DARPA/ITO

ATTN: BAA 98-02

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